chapter four

PLANTS

Plants are the primary food source for **salt marsh** ecosystems, and most plant material is consumed as **detritus** by decomposers and **invertebrate** consumers. A salt marsh is physically dependent on its plants — plant roots and stems anchor the **substrate** and enable the gradual build up of peat. The plants, along with physical **parameters** such as tides and geology and chemical parameters such as salinity, create the template for salt marshes and enable invertebrates, fish, birds, and even humans to benefit from these resources.

Salt marshes can be extremely difficult places to live because of wide daily fluctuations in salinity, water, temperature, and oxygen. Few plants have evolved adaptations to cope with the extreme conditions of salt marshes, and by examining healthy marshes, scientists have become familiar with these plants and their environmental requirements. Plant **zonation** (see: Chapter Two) in a salt marsh results from **species**-specific adaptations to physical and chemical conditions. Looking out on a healthy marsh in full summer growth, one can observe distinct zones of plant growth. Bands of tall grasses inhabit the saturated banks of creeks and bays, and this zone is bordered by a flat "meadow" of grasses and sedges that may extend landward for a great distance before transitioning into upland **habitats** where there is a greater diversity of shrubs, flowering plants, and grasses.

Plant communities respond to **human disturbances** and subsequent changes in salinity, natural **hydrology**, **invasive species**, or pollutants. Volunteer groups may compare a disturbed marsh with an undisturbed marsh to see how vegetation has responded to the disturbance. For example, a volunteer group may study the plant **communities** in two salt marshes on either side of a railroad bed to try to understand how the restriction altered what was once a contiguous ecosystem. A volunteer group may also study plant communities in one salt marsh over time and watch how vegetation may change in response to the introduction and proliferation of invasive species such as *Phragmites australis* (common reed) or freshwater **wetland** species such as *Typha latifolia* (broad-leaf cattail). Many types of disturbance allow plants that could not otherwise live in salt marshes to gain a foothold, reproduce, and compete with native species.

Plants are an important and easy parameter for volunteer monitors to measure. Equipment cost is very low compared with other parameters and volunteers only need to sample once or twice a year. Many people are familiar with wetland plants, and those who are not will find numerous field guides with excellent illustrations and photographs. Volunteer groups may want to measure salinity and tidal influence concurrently with vegetation because the three are closely linked.

EQUIPMENT

Salt marsh vegetation surveys require minimal equipment, listed in Table 1. Much of this equipment is also required to monitor other parameters, such as flagging, stakes, and a tape measure. Therefore, the only equipment

Phragmites australis
"COMMON REED"
Non-Native? Invasive?

Recent research on *Phragmites australis* using advanced DNA genotyping tools demonstrates that there are native and non-native strains present in North America. In the last 40 years, one of the non-native strains has proliferated throughout the country, altering native plant communities and wetland ecosystems (Saltonstall, 2002). This type appears to be aggressive and competitively superior to the native strains. Throughout this document, the authors will refer to *Phragmites australis* as "invasive" rather than "non-native" to reflect our current understanding of this species.

Photo by Paul Godfrey

that volunteer groups need to purchase or construct that is unique to plants is a $1m^2$ square **plot sample** frame and a reliable field guide to wetland plants. The $1m^2$ plot frame can be constructed from ½ inch PVC material. Although stakes come in a variety of materials, PVC is good because it is durable and lasts for a long time.

TABLE 1. PLANT SAMPLING EQUIPMENT

EQUIPMENT
1 100-meter field tape measure with wind-handle
24 Stakes (5 ft. lengths of ½ or 1 in. diam. PVC)
$1m^2$ plot
Compass (and/or GPS)
Field guide to coastal wetland plants
Clipboard
Pencils
Field data sheet
Large Ziploc bags

SAMPLING METHODS

At each site, you will survey vegetation according to a standard protocol. It is important that the plant survey follows the methodology outlined in Chapter Three for using a comparative approach and establishing **evaluation areas**.

Establishing Evaluation Areas, Transects, and Plots

Establish the evaluation areas for the salt marshes your group will be **monitoring.** The project leader usually does this using the steps outlined in Chapter Three. NOTE: If a creek or river channel bisects the salt marsh (this is the case for most tide restricted sites), your group may want to survey the plants on both sides — your leader will help to decide this. If so, your group will be establishing two sets of **transects** as explained below, one set on each side of the channel.

1. Stratify the evaluation area into three sections as follows (Figure 1a,b):
   a. Section 1 is the area between the starting point of the evaluation area (0') and a point 100' along the creek, bay, or salt pond.
   b. Section 2 is the area between 100' and 200' along the creek, bay, or salt pond.
   c. Section 3 is the area between 200' and 300' along the creek, bay, or salt pond.

2. Randomly generate numbers for the location of two transects within each section (six per evaluation area). Transect locations can be determined using a calculator that has a function for generating random numbers, or Microsoft Excel can generate random numbers between two numbers (in this case 0 and 100) using the command: =RAND( )*100. You can

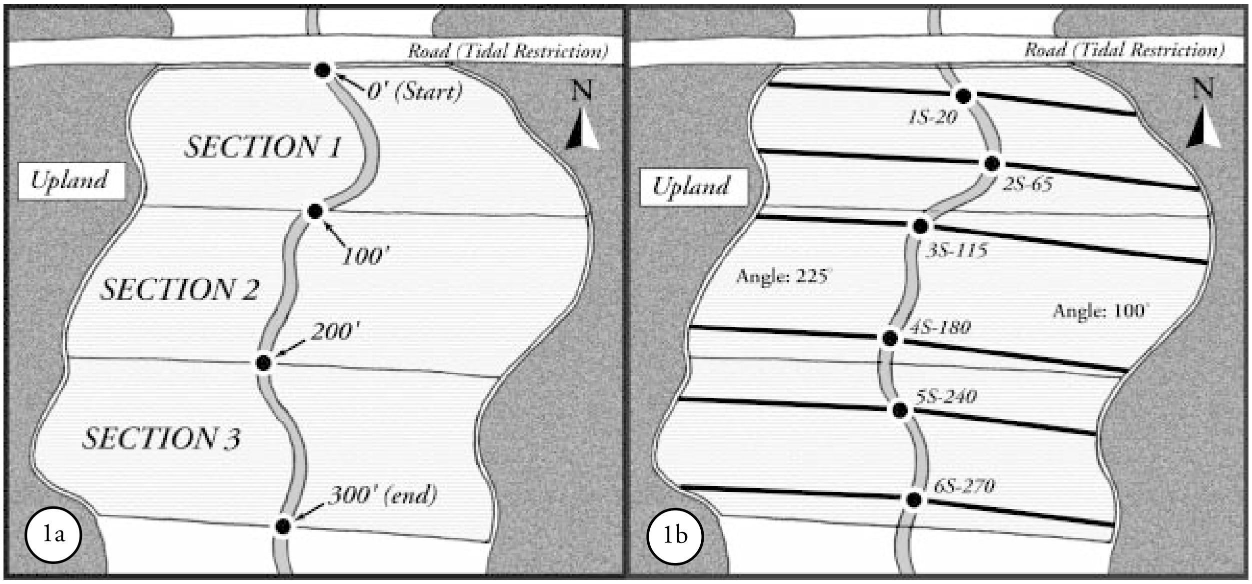


FIGURE 1. EVALUATION AREA AND TRANSECT PLACEMENT
Figure 1a shows the three sections within a wetland evaluation area on one side of a tidal restriction. Figure 1b shows transect placement within each section. See text for details.

generate random numbers in the office before going out to the marsh. The random number is the distance in feet from the beginning of each section and marks the starting location of each transect. If the location of a transect places it on a ditch, within 3 feet of another transect, or some other unworkable location, then use another number/location.

3. Transects run from the bank to the upland edge, according to a consistent compass bearing (for example, all six transects will be laid on a bearing of 225 degrees from the bank to upland edge) (Figure 1b). One member should stand at the creek with a compass and one end of the measuring tape. Another group member should walk toward the upland edge with the measuring tape and move until their position matches the compass reading.

4. For groups monitoring both sides of a river or channel, establish a second set of transects in the same manner as the first. If the location or compass bearing for the second set of transects yield awkward or unworkable transect locations, such as transects falling directly on channels or excessively long transects, then use a new compass bearing for the second set. As a rule and to ensure consistency, always label the two sides of the marsh. You may use the cardinal directions of the compass — for example, the northwest side and the southeast side of the channel. Figure 1b shows transect placement within a wetland evaluation area, and Table 2 shows how to label plots and transects.

5. Secure a stake at each end of the transect and label it according to the protocol shown in Table 2. Be sure to solidly plant the stake into the ground. The stake will enable your group to find the same transects next season, and the labeling will avoid confusion.

STRATIFIED RANDOM SAMPLING

In vegetation monitoring, six transects are established within each evaluation area using a stratified random design. This terminology sounds intimidating, but it is quite simple when broken down. The random assignment of transects helps to eliminate bias and the intentional targeting of a certain species or community. Stratified means layered or segmented, and in this case, it means that the evaluation area is divided into three segments. Stratifying the sampling area helps avoid the situation whereby all six transects happen to be clustered together and do not provide adequate spatial coverage of the evaluation area. This approach allows the investigator to use statistical tools to analyze data and draw conclusions about the evaluation areas.

TABLE 2. AN EXAMPLE OF TRANSECT LABELING

SITE CODE	DISTANCE (random number)	TRANSECT # AND EVALUATION AREA	TRANSECT LABEL
HW-Study	19.9	1-North	1N-19.9
HW-Study	74.4	2-North	2N-74.4
HW-Study	184.2	3-North	3N-184.2
HW-Study	199.9	4-North	4N-199.9
HW-Study	263.9	5-North	5N-263.9
HW-Study	291.4	6-North	6N-291.4

6. Place 1m^2 plots every 60 feet along each transect, starting at the bank and progressing toward the upland edge. Plots should be located every 30 feet if the transect length is less than 120 feet. The first plot is always placed at the beginning of the transect and the last plot is placed in the salt marsh border regardless of whether or not the 30 or 60 foot interval falls there. For example, your group finished the 240 foot plot and is following the transect out to position the next plot at 300 feet. The salt marsh ends at about 285 feet, so that a plot at 300 feet would be located in the upland. In this case, you should establish the last plot at 280 feet in the salt marsh border and make sure this location (280') is recorded on the field data sheet.

Collecting Data

1. Always walk on the left side of the tape measure and place the plots on the right side. This way you are not trampling plants you intend to survey and you know that plot position is consistent. Also, position the plots so that the bottom left-hand corner of the frame is always located at the designated distance on the measuring tape (e.g. at 120 feet).

2. Starting at the first plot on the first transect, identify every plant that falls within the 1m^2 plot frame. Use your field guide to identify any plant in question. Record the plant community type within each plot, (**low marsh**, **high marsh**, or marsh border).

3. Record the scientific name (genus and species) of each species on the field data sheet.

4. Estimate the **abundance** of each species. Using the worksheet in Appendix 2 of this chapter, select the cover class that most accurately portrays the abundance of each species in the plot. Include all leaves, branches, and stems that fall within the vertical column made by the plot frame extended upwards. It is fine if the total abundance for all the species in the plot is over 100%, as plants will overlap each other.

5. Plot coverage estimates should include areas within the plot frame that are not occupied by living vascular plants, called "Other." This category includes duff, old dead leaves, bare ground, and open water. During the data analysis stage, you can adjust abundance values to account for the "Other" category.

6. If the management or control of *Phragmites australis* (or another species) is an objective of your study, then it is important to document the relative health and vigor of this plant. In at least three plots where *Phragmites australis* occurs, your group should measure the height of the tallest 10 living individuals. Measure from the ground to the very tip of the inflorescence (flowering part of the plant), or if no inflorescence is present, measure to the tip of the highest leaf. The field data sheet in Appendix 1 of this chapter contains a section for this information.

Plant Identification

Proper identification of wetland plants is an important skill for salt marsh vegetation monitoring. Fortunately, New England salt marshes support a low diversity of plants, and the number of species that volunteers will regularly see is limited. Volunteers should try to gain experience with plant **morphology** and plant ecology to become competent with species identification. Several books integrate key information on identification, ecology, and distribution and are invaluable to those without a strong **taxonomy** background.

One of the best publications available for northeastern North America is *A Field Guide to Coastal Wetland Plants of the Northeastern United States* (Tiner 1987). This field guide provides excellent drawings, clear descriptions, and user-friendly keys for 59 species found in salt and brackish marshes, as well as many other plants found in freshwater wetlands.

If you have trouble identifying a specimen using Tiner (1987) or a different field guide, you should call the specimen "Unknown Species A" in your field data sheet and place the plant and part of its roots into a resealable plastic bag (along with a label) for later identification. Once you identify the plant, you can go back and adjust your spreadsheet or database accordingly. It may also be a good idea to keep specimens of plants that you are *pretty sure* you identified properly, but still need some confirmation from someone with more experience. Getting hands-on instruction and spending time in the field with someone with expertise in wetland plant identification is a great way of learning to identify plants. Your project leader may have such experience, or may be able to arrange for a training session, or get a commitment from a wetland professional to join your group for an afternoon.

DATA ENTRY

You should use one field data sheet for each transect. Number the transects as shown in Table 2. The field data sheet requires basic information such as the name of the investigator(s), the survey date, site name, transect ID, and compass bearing of each transect. The rest of the field data sheet is divided into plot-by-plot sections, and at the end there is a section to record target species height (i.e. *Phragmites australis*). A blank standard field data sheet is provided in Appendix 1 of this chapter.

In the field, you should take the time to thoroughly fill out basic information and make sure that site-specific information is recorded in the proper location so that you do not confuse data sheets from different transects or even different sites! Always spend time reviewing each data sheet, double-checking that you have entered all the necessary information — an extra minute in the field could save hours later.

In the office, investigators should transfer information on field data sheets into a computer spreadsheet such as Microsoft Excel or perhaps a database such as Microsoft Access. Each site should have its own table, spreadsheet, or worksheet. The primary objective is to enter raw data into the spreadsheet and then use functions and tools available in the software to consolidate all of the numerous plots into a cumulative list and to compute the total abundances of species for the evaluation area.

Juncus gerardii
Black Grass

Spartina patens
Salt Hay Grass

Steps in Data Entry

The following section outlines the steps volunteers should take when entering data into a spreadsheet. The text includes figures that show spreadsheet format and use real data to illustrate key aspects of data entry. Tables 3, 4, and 6 are set up similar to a spreadsheet with column and row identifiers (letters for columns and numbers for rows), so that any cell in the figure can be identified. For example, cell D12 is located in column D and row 12.

1. For each evaluation area, set up a table or spreadsheet with five columns for Site Code, Plot ID, Community Type, Genus Species, and Plot Cover. The plot ID is the transect number and location of the plot on that transect. The example provided in Table 3 is for one transect (1N) with four plots (0', 60', 120', 166'). Your spreadsheet will be much longer because it will include data for all transects at the study site (six or twelve transects, depending on your study).

TABLE 3. EXAMPLE DATA ENTRY SPREADSHEET, STEP ONE

	A	B	C	D	E
1	**SITE CODE**	**PLOT ID**	**COMMUNITY**	**GENUS SPECIES**	**PLOT COVER**
2	HW-Study	1N0	Low	Spartina alterniflora	76
3	HW-Study	1N0	Low	Salicornia europaea	1
4	HW-Study	1N0	Low	Other	25
5	HW-Study	1N60	High	Distichlis spicata	55
6	HW-Study	1N60	High	Spartina patens	38
7	HW-Study	1N60	High	Other	15
8	HW-Study	1N120	High	Phragmites australis	38
9	HW-Study	1N120	High	Distichlis spicata	38
10	HW-Study	1N120	High	Other	25
11	HW-Study	1N166	Border	Phragmites australis	76
12	HW-Study	1N166	Border	Solidago sempirvirens	15
13	HW-Study	1N166	Border	Juncus gerardii	15
14	HW-Study	1N166	Border	Other	7

TABLE 4. EXAMPLE DATA ENTRY SPREADSHEET, STEPS TWO AND THREE

	A	B	C	D	E	F
1	**SITE CODE**	**PLOT ID**	**COMMUNITY**	**GENUS SPECIES**	**PLOT COVER**	**TOTAL PLOT COVER**
2	HW-Study	1N60	High	Distichlis spicata	55	
3	HW-Study	1N120	High	Distichlis spicata	38	93
4	HW-Study	1N166	Border	Juncus gerardii	15	15
5	HW-Study	1N0	Low	Other	25	
6	HW-Study	1N60	High	Other	15	
7	HW-Study	1N120	High	Other	15	
8	HW-Study	1N166	Border	Other	7	62
9	HW-Study	1N120	High	Phragmites australis	55	
10	HW-Study	1N166	Border	Phragmites australis	76	131
11	HW-Study	1N0	Low	Salicornia europaea	1	1
12	HW-Study	1N166	Border	Solidago sempirvirens	15	15
13	HW-Study	1N0	Low	Spartina alterniflora	76	76
14	HW-Study	1N60	High	Spartina patens	38	38

2. Copy Table 3 to a new spreadsheet (this will enable you to go back and look at the raw data). On the new spreadsheet, select all cells in the table, go to Data → Sort, select the column "Genus Species" (column D), and select "Sort Ascending." This results in a sheet similar to Table 4 with plant species in alphabetical order.

3. Sum the plot cover values for each species, using the SUM function (under Insert → Function → Math & Trig). For example, in Table 4 the value in cell F3 is computed using the equation "=SUM(E2:E3)" and represents the total plot cover value of *Distichlis spicata* at transect 1N. This summation should be done for all species in the transect and all transects at the site.

TABLE 5. EXAMPLE DATA ENTRY SPREADSHEET, STEP FOUR

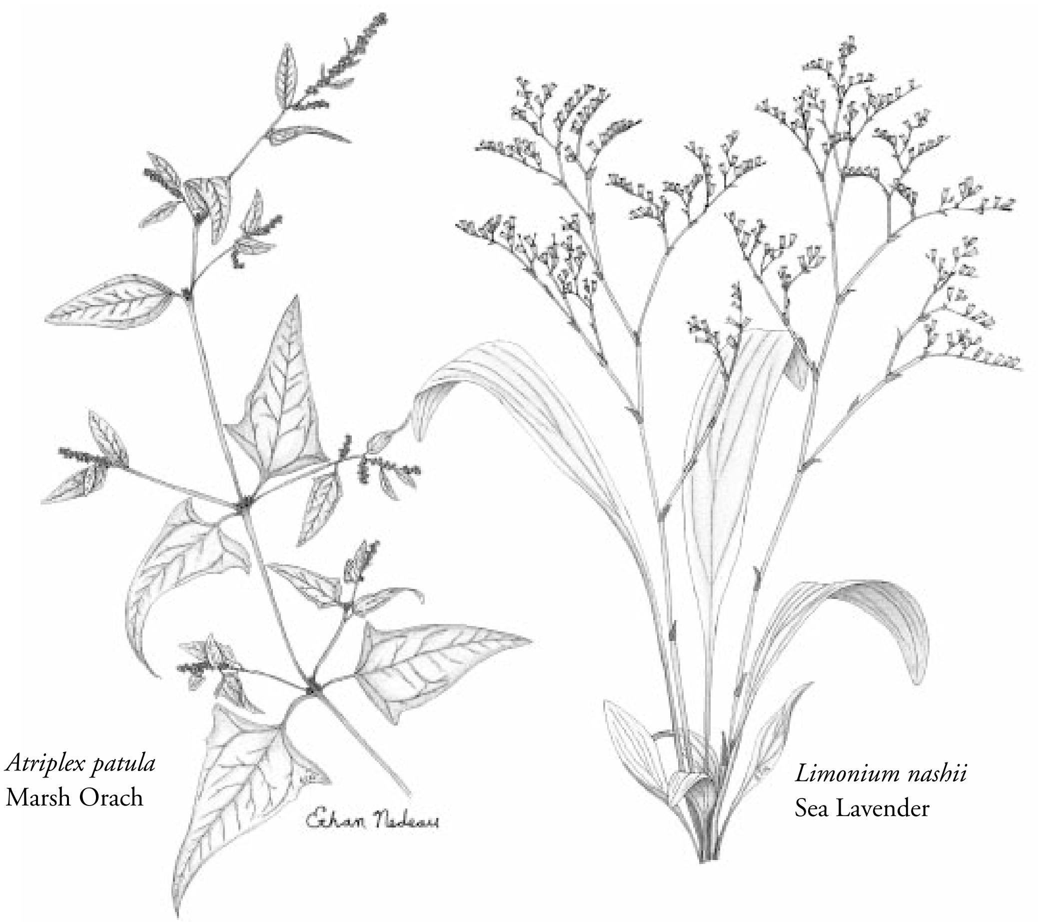
SITE CODE	GENUS SPECIES	TOTAL PLOT COVER
HW-Study	Atriplex patula	9
HW-Study	Distichlis spicata	585
HW-Study	Iva frutescens	159
HW-Study	Other	1202
HW-Study	Phragmites australis	869
HW-Study	Salicornia europaea	31
HW-Study	Scirpus pungens	20
HW-Study	Solidago sempirvirens	24
HW-Study	Spartina alterniflora	1349
HW-Study	Spartina patens	382
HW-Study	Typha angustifolia	47
	Total Abundance	4677

4. Create a new table with three columns for Site Code, Genus Species, and Total Plot Cover (Table 5). Table 5 represents data for all transects at the study site. You should combine data for all six or twelve transects at the study site when completing Table 5. Notice that the "Other" category remains in the column "Genus Species." This category is important because it indicates the relative amount of non-vegetated marsh in the survey plots, though you will generally analyze results without this category. Copy Table 5 to another worksheet and delete the "Other" category.

5. Add a fourth column to Table 5 called "Percent Abundance" (Table 6). Sum column C in Table 6 by typing the formula "=SUM(C2:C11)" in cell C12. This represents Total Abundance. To compute Percent Abundance, divide Total Plot Cover for each species by Total Abundance of all species and multiply by 100. For example, the Percent Abundance of *Distichlis spicata* is computed using the formula "=(C3/3475)*100." The sum of column D should equal 100. Complete this step for both the study site and **reference site**. You will work with this set of compiled data for many of the data comparisons suggested in the following section.

TABLE 6. EXAMPLE DATA ENTRY SPREADSHEET, STEP FIVE

	A	B	C	D
1	SITE CODE	GENUS SPECIES	TOTAL PLOT COVER	PERCENT ABUNDANCE
2	HW-Study	Atriplex patula	9	0.26
3	HW-Study	Distichlis spicata	585	16.83
4	HW-Study	Iva frutescens	159	4.58
5	HW-Study	Phragmites australis	869	25.01
6	HW-Study	Salicornia europaea	31	0.89
7	HW-Study	Scirpus pungens	20	0.58
8	HW-Study	Solidago sempirvirens	24	0.69
9	HW-Study	Spartina alterniflora	1349	38.82
10	HW-Study	Spartina patens	382	10.99
11	HW-Study	Typha angustifolia	47	1.35
12		**Total**	3475	100



Atriplex patula
Marsh Orach

Limonium nashii
Sea Lavender

DATA ANALYSIS AND COMPARISON

Once you enter and compile data into a spreadsheet, your group can begin to analyze and compare the data. Many different tools and techniques exist to analyze biological data. This chapter provides a detailed description of five types of **variables**: species richness, species abundance, community composition, target species, and occurrence frequency. Project leaders may decide to explore other types of analysis, such as descriptive statistics or other community metrics and indices. For this section, two sample data sets are used to illustrate key concepts; these data are from a tide restricted site (HW-Study) and its unrestricted reference counterpart (HW-Ref).

Species Richness

Description: Species richness is the number of different species (or genera) that were documented at a particular site.

Calculation: Simply count the number of species at each site. In addition, you can compute a ratio of species richness at the study site and reference site. In Table 7, species richness is 10 and 14 for the study site and reference site, respectively. The ratio is 10/14 = 0.71, or 71%, meaning the study site has 29% fewer species than the reference site.

Interpretation: Species richness is an important variable because in general pristine salt marshes will generally support more species than disturbed salt marshes; that is, high species diversity is usually associated with favorable conditions. Disturbance often eliminates sensitive species, and favors the proliferation of a few **generalist** or **opportunistic** species. The ratio of species richness at the study site and reference site is informative, but it's meaning is somewhat subjective. Table 8 (page 4-10) provides general guidelines to make a qualitative interpretation of this ratio. These guidelines should be considered in the context of other attributes of the plant community or other parameters.

One of the best ways to appraise the condition of a salt marsh in terms of species diversity is to look at species diversity over time. Data sets from different years at the same site (including evaluation area and transects) may

TABLE 7. SPECIES RICHNESS AND RELATIVE ABUNDANCE

SITE CODE	GENUS SPECIES	PERCENT ABUNDANCE
HW-Study	Spartina alterniflora	38.82
HW-Study	Phragmites australis	25.01
HW-Study	Distichlis spicata	16.83
HW-Study	Spartina patens	10.99
HW-Study	Iva frutescens	4.58
HW-Study	Typha angustifolia	1.35
HW-Study	Salicornia europaea	0.89
HW-Study	Solidago sempirvirens	0.69
HW-Study	Scirpus pungens	0.58
HW-Study	Atriplex patula	0.26
HW-Ref	Spartina patens	63.64
HW-Ref	Spartina alterniflora	18.94
HW-Ref	Distichlis spicata	13.41
HW-Ref	Phragmites australis	1.52
HW-Ref	Atriplex patula	0.58
HW-Ref	Pluchea purpurascens	0.49
HW-Ref	Aster tenuifolius	0.38
HW-Ref	Solidago sempirvirens	0.29
HW-Ref	Salicornia europaea	0.27
HW-Ref	Juncus gerardii	0.18
HW-Ref	Limonium nashii	0.15
HW-Ref	Plantago maritima	0.06
HW-Ref	Agalinis maritima	0.06
HW-Ref	Agropyren pungens	0.04

indicate a trend. A marked increase of species richness over time may be strong evidence of improving conditions and successful restoration.

Relative Abundance

Description: Relative abundance is the proportion of a community comprised of a certain species or group of species. In this chapter, volunteers compute relative abundance using plot cover values.

Calculation: You calculated percent abundance values during data entry (Step Five, Table 6). For data analysis and comparison, it is useful to sort the percent abundance values from high to low. To do this, select the entire table, go to Data → Sort, select the column "Percent Abundance," and select "Sort Descending." Do this for the study site and reference site (Table 7). Beginning at the top of the third column, sum relative abundance values until you reach 75% and record the number of species it takes to reach 75%. In Table 7, it takes three species to reach 75% in the study site and two species to reach 75% in the reference site.

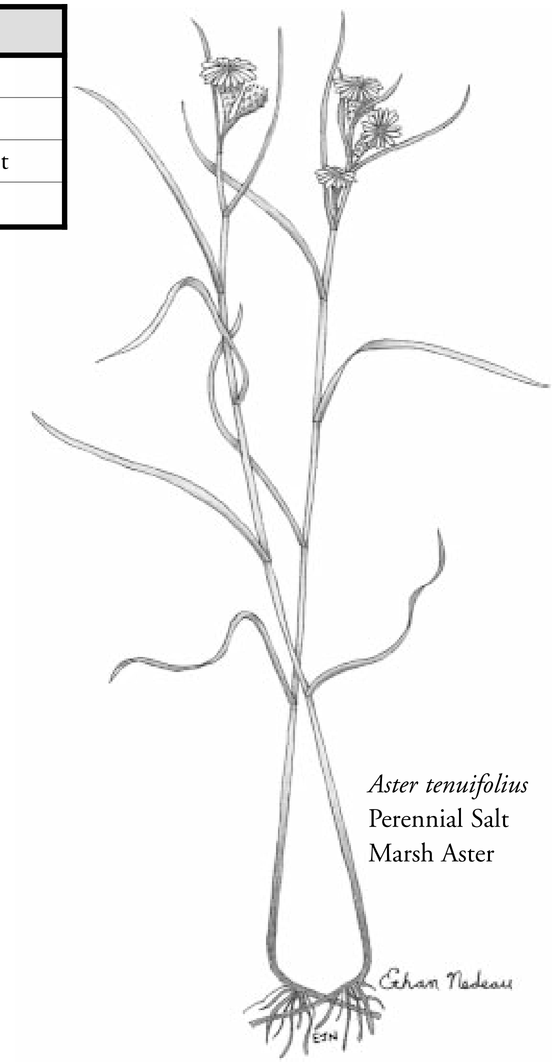
Interpretation: There are several different ways to interpret relative abundance values, and particularly how relative abundance relates to species richness. One way to look at relative abundance is to look at the relative abundance of particular species. For example, a salt marsh may have high species richness but one species may account for over 80% of the total biomass; an extraordinarily high abundance of one species would greatly affect the variety and quality of habitats in the marsh. A second way to look at relative abundance is the 75% rule, which is the number of species that comprise at least 75% of a plant community.

Dominant species may indicate certain characteristics of the marsh. For example, a great abundance of *Spartina alterniflora* indicates that a low marsh community is a dominant feature in a marsh, and investigators may want to explore possible explanations for this observation. Two possible explanations are that tidal restriction caused compaction of the marsh surface or that water levels are locally higher — either of these explanations would create favorable conditions for a low marsh community. Low marsh habitat is more available to sub-tidal foragers and predators like fish and crabs, as it is more frequently flooded than high marsh.

One of the best ways to appraise the condition of a salt marsh is to look at changes over time. Data sets from different years at the same site (including evaluation area and transects) may indicate a trend. Significant shifts in species abundance from one year to another can indicate changes in local conditions. For example, increasing abundance of brackish or freshwater species can indicate a "freshening" of the marsh, possibly due to the effects of a tidal restriction.

TABLE 8. GUIDELINES TO INTERPRET RATIOS

RATIO	INTERPRETATION
0.76 - 1.00	High similarity, no assumed impairment
0.51 - 0.75	Fair similarity, assumed minimal impairment
0.26 - 0.50	Poor similarity, assumed moderate impairment
0.0 - 0.25	Dissimilar, assumed severe impairment



Aster tenuifolius
Perennial Salt
Marsh Aster

Community Composition

Description: Community composition refers to the types of species that occur in a community, and particularly the similarity or difference between two different communities. The previous two variables focused on the number of species and the abundance of species. Two sites may have similar species richness and relative abundance, but support entirely different species. Since different species have different environmental requirements, the types of species in a community provide clues about salt marsh condition.

Calculation: One way to examine community composition is to compare the species lists of two or more sites and see how many unique species exist at each of the sites. Generate a species list for each site, sort the species alphabetically, and place the lists side-by-side to compare them. Table 9 demonstrates how this looks in a spreadsheet. From Table 9, you can see that the two sites share seven species, the reference site has seven unique species, and the study site has three unique species. You can calculate a community similarity ratio by dividing the number of species that the study site and reference site share (in our example, 7) by the number of species at the reference site (in our example, 14). The ratio is 7/14 = 0.50, or 50%.

Interpretation: When interpreting community composition data, it is important to have an understanding of the environmental tolerance and ecology of the plant species. If a study site has five unique species, you should ask yourself, "What traits do these five species share that might help explain why they are not also found at the reference site?" Perhaps they are brackish or freshwater species, and their occurrence in the study site indicates a tidal restriction or freshwater intrusion. Alternatively, perhaps they are invasive or opportunistic species that are known to colonize disturbed habitats.

The community similarity ratio is a quick way to judge the how similar two wetlands are in terms of plant communities, but the interpretation of this ratio is somewhat subjective. Table 8 provides some general guidelines to make a qualitative interpretation of this ratio. These are only guidelines, and it is more important to look at actual species composition rather than relying on this simple ratio.

Target Species

Description: Target species are species whose presence and abundance is particularly relevant to the goals or objectives of a monitoring project, or provide important clues about ecosystem processes and health. Volunteer groups may want to track the presence, abundance, and growth of these species. Examples include *Phragmites australis* because it is invasive and usually detrimental to wetlands, certain brackish or freshwater species such as *Typha latifolia* or *Lythrum salicaria* (purple loosestrife) because they provide clues about hydrology, or even common salt marsh species to show how they respond to restoration projects.

TABLE 9. COMMUNITY COMPOSITION EXAMPLE

HW-STUDY	HW-REF
Agalinis maritima	
Agropyren pungens	
Aster tenuifolius	
Atriplex patula	Atriplex patula
Distichlis spicata	Distichlis spicata
Juncus gerardii	
	Iva frutescens
Limonium nashii	
Phragmites australis	Phragmites australis
Plantago maritima	
Pluchea purpurascens	
Salicornia europaea	Salicornia europaea
	Scirpus pungens
Solidago sempirvirens	Solidago sempirvirens
Spartina alterniflora	Spartina alterniflora
Spartina patens	Spartina patens
	Typha angustifolia

Salicornia europaea
Common Glasswort

Calculation: One way to track a target species is to simply document its presence and abundance at each site. In Table 7, you can see that *Phragmites australis* is present at the study site and reference site, but its abundance is 25% at the study site and only 1.5% at the reference site. In other words, *Phragmites australis* is nearly 17X more abundant in the study site.

Your group also may have taken measurements of the height of the 10 tallest individuals of *Phragmites australis* (or other target species) at a number of plots (three minimum recommended). If so, compute the average height of all plants measured at each site. Table 10 shows the results of from the tidally restricted HW-Study and its unrestricted reference counterpart, HW-Ref (Note that *Phragmites australis* heights were measured in three plots at the study site, but since it occurred in only one plot at the reference site, only 10 plants were measured).

Interpretation: Tracking target species can be an important part of volunteer monitoring. In salt marshes, **populations** of the invasive *Phragmites australis* have greatly increased over the past several decades. Resource managers are concerned about this species because it aggressively colonizes new habitats, and alters natural habitat functions and values. The presence of large and increasing stands of *Phragmites australis* usually indicates some type of disturbance or environmental stress, including altered hydrology, filling, stormwater discharge, road salts, or other water pollution. There are no established criteria to judge when the abundance of *Phragmites australis* (or another target species) is a problem, but in general when *Phragmites australis* is a dominant species or its population is increasing, there is probably some underlying reason as to why conditions in the marsh are changing to favor this species. Use paired or regional reference sites for indications of what might be natural and stable populations of *Phragmites australis.*

TABLE 10. *PHRAGMITES* HEIGHT MEASUREMENTS

Phragmites MEASUREMENT	HW-REF	HW-STUDY
Average Height	5.6	9.2
Number Measured	10	30

Compare the average height of your target species at the study site and reference site. How do these average heights compare? Is one much larger? How great is this difference? You may explore other descriptive statistics such as minimum, maximum, range (maximum-minimum), standard deviation, and standard error (functions for these statistics are found in Insert → Function → Statistical). Average height and standard deviation can be plotted on a simple bar graph to provide a nice visual representation of your data. If you have a good background in statistics, you may perform a statistical test to determine if the two sets of plant heights are significantly different.

Collectively, the presence, abundance, and growth of target species may provide important information about salt marsh condition. However, be cautious when drawing conclusions about the meaning of these data, since there are several possible explanations for different plant communities at different sites. Groups may want to explore other parameters such as tidal hydrology and salinity to understand underlying causes for vegetation patterns.

Occurrence Frequency

Description: Occurrence frequency is simply how often a species appears in your plots. This can be expressed as a percentage, and along with relative abundance provides information about the spatial distribution of a species.

Calculation: Examine the data table you created in Step Two of the data entry section (example shown in Table 4). Count the number of times that each species occurs in the list to determine its occurrence frequency (include all plots and transects at a site). This should be easy because the species are arranged alphabetically. Divide each species' occurrence frequency by the number of plots your group surveyed and multiply by 100 to express it as a percentage.

Interpretation: Occurrence frequency and relative abundance go hand-in-hand, and when used together tell about the spatial distribution of a species. A species with a high frequency of occurrence but a low total abundance will be distributed well over the marsh but with only small numbers of individuals. A low frequency of occurrence with a high abundance would indicate that the species occurs in larger isolated patches. Occurrence frequency and relative abundance are helpful for comparing plant communities in different marshes, or tracking changes in vegetation communities in a single marsh over time (such as before and after removal of a tidal restriction).

References and Other Suggested Reading

Bertness, M.D. and A.M. Ellison. 1987. Determinants of pattern in a New England salt marsh plant community. *Ecological Monographs* 57(2): 129-147.

Bertness, M.D. 1999. *The Ecology of Atlantic Shorelines*. Sinauer Associates, Sunderland, MA.

Gleason, H.A. and A. Cronquist. 1991. *Manual of Vascular Plants of Northeastern United States and Adjacent Canada*. The New York Botanical Garden, Bronx, NY.

Niering, W.A. and R.S. Warren. 1980. Vegetation patterns and processes in New England salt marshes. *BioScience* 30(5): 301-307.

Saltonstall, K. 2002. Cryptic invasion by a non-native genotype of the common reed, Phragmites australis, into North America. *Proceedings of the National Academy of Sciences* 99(4): 2445-2449.

Tiner, R.W. 1987. *A Field Guide to Coastal Wetland Plants of the Northeastern United States*. The University of Massachusetts Press, Amherst, MA.

Tiner, R.W. 1993. *Coastal Wetland Plants of the Southeastern United States*. The University of Massachusetts Press, Amherst, MA.

Distichlis spicata
Spike Grass

chapter four

APPENDICES

APPENDIX 1. PLANT SURVEY FIELD DATA SHEET
APPENDIX 2. COVER CLASS WORKSHEET

NOTES

PLANT SURVEY FIELD DATA SHEET

Investigators: ______________________________

____

Site Name: ______________________________

Date: ______________________ **Reference or Study (circle)**

Transect Number: ______________________________

Distance from Origin Point: ______________________________

Compass Bearing of Transect: ______________________________

Plot ID: ______________________________

Location on Transect (feet): ______________________________

Community Type (low, high, border):

GENUS	SPECIES	% COVER (MIDPOINT VALUE)
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
OTHER	OTHER	

Plot ID: ______________________________

Location on Transect (feet): ______________________________

Community Type (low, high, border):

GENUS	SPECIES	% COVER (MIDPOINT VALUE)
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
OTHER	OTHER	

Plot ID:
Location on Transect (feet):
Community Type (low, high, border):

GENUS	SPECIES	% COVER (MIDPOINT VALUE)
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
OTHER	OTHER	

Plot ID:
Location on Transect (feet):
Community Type (low, high, border):

GENUS	SPECIES	% COVER (MIDPOINT VALUE)
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
OTHER	OTHER	

Plot ID:
Location on Transect (feet):
Community Type (low, high, border):

GENUS	SPECIES	% COVER (MIDPOINT VALUE)
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
OTHER	OTHER	

Plot ID:

Location on Transect (feet):

Community Type (low, high, border):

GENUS	SPECIES	% COVER (MIDPOINT VALUE)
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
OTHER	OTHER	

Plot ID:

Location on Transect (feet):

Community Type (low, high, border):

GENUS	SPECIES	% COVER (MIDPOINT VALUE)
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
OTHER	OTHER	

Plot ID:

Location on Transect (feet):

Community Type (low, high, border):

GENUS	SPECIES	% COVER (MIDPOINT VALUE)
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
OTHER	OTHER	

Plot ID:
Location on Transect (feet):
Community Type (low, high, border):

GENUS	SPECIES	% COVER (MIDPOINT VALUE)
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
OTHER	OTHER	

Plot ID:
Location on Transect (feet):
Community Type (low, high, border):

GENUS	SPECIES	% COVER (MIDPOINT VALUE)
1)		
2)		
3)		
4)		
5)		
6)		
7)		
8)		
OTHER	OTHER	

OPTIONAL: HEIGHT OF TALLEST 10 LIVING PHRAGMITES IN PLOT

Plot ID:
Location on Transect (ft):

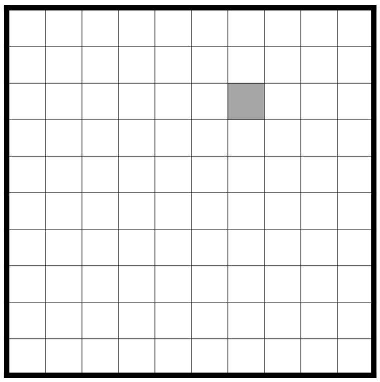
PLANT	HEIGHT (cm)	PLANT	HEIGHT (cm)
#1		#6	
#2		#7	
#3		#8	
#4		#9	
#5		#10	

Average Height of 10 Individual Plants:

Salt Marsh Vegetation Survey

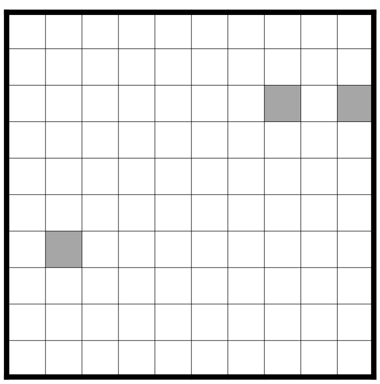
Standard Cover Classes and Midpoints for Estimating Abundance

One method for obtaining abundance values is to estimate the percent of a plot occupied by the target plant. To assess percent cover, one estimates the area of the plot frame ($1m^2$) that is covered by all of the leaves, branches, and stems of the target species. Since visual estimates may vary from one person to another, standard cover classes and midpoint abundance values are used to reduce variability. The following figures illustrate nine standard cover classes. For each plot, first identify and list the species present, then for each species determine which figure best describes its cover. Record the midpoint value on the data sheet.



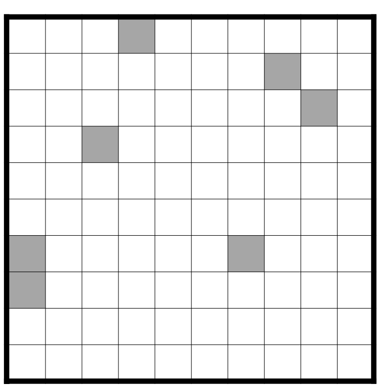
(Trace to 1%)

Use 1%



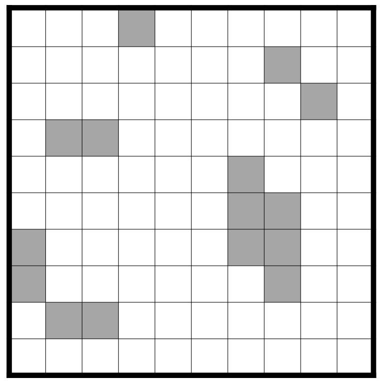
(2% to 4%)

Use midpoint 3%



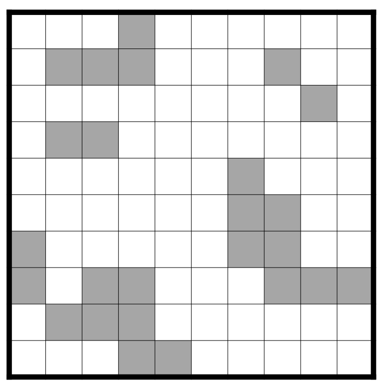
(5% to 10%)

Use midpoint 7%



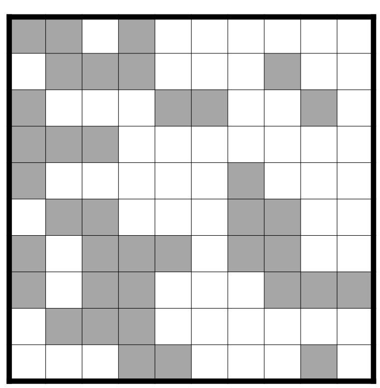
(11% to 19%)

Use midpoint 15%



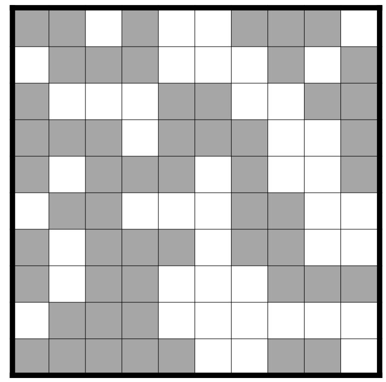
(20% to 30%)

Use midpoint 25%



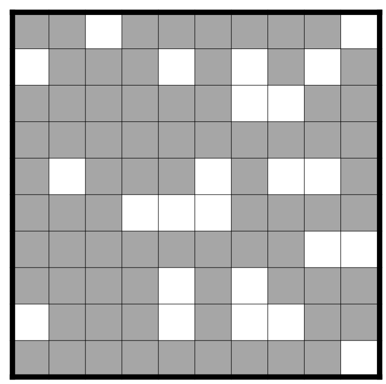
(31% to 45%)

Use midpoint 38%



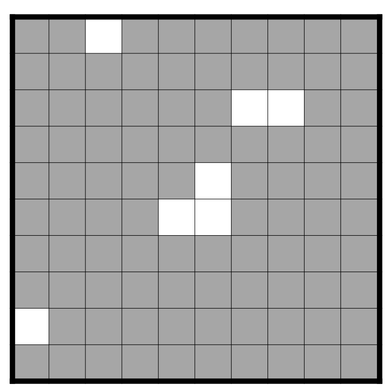
(46% to 64%)

Use midpoint 55%



(65% to 87%)

Use midpoint 76%



(88% to 100%)

Use midpoint 94%